

5       **SPORT BALL WITH SELF-CONTAINED INFLATION MECHANISM HAVING  
PRESSURE RELIEF AND INDICATION CAPABILITY**

**Cross Reference to Related Applications**

          This application claims priority upon U.S. provisional application Serial  
No. 60/435,225 filed December 20, 2002.

10                   **Field of the Invention**

          The present invention relates to sport or game balls that contain  
mechanisms for inflating or adding pressure to the balls. The inflation  
mechanisms additionally utilize an integral pressure relief assembly, and/or an  
15   integral pressure indicating device.

**Background of the Invention**

          Conventional inflatable sport balls, such as basketballs, footballs, soccer  
20   balls, volleyballs and playground balls, are inflated through a traditional inflation  
valve using a separate inflation needle that is inserted into and through a self-  
sealing inflation valve. A separate pump, such as a traditional bicycle pump, is  
connected to the inflation needle and the ball is inflated using the pump. The  
inflation needle is then withdrawn from the inflation valve that self-seals to  
25   maintain the pressure within the ball. This system works fine until the sport ball  
needs inflation or a pressure increase and a needle and/or pump are not readily  
available.

In conventional sport balls, there is no easy way to relieve the pressure of the ball. A separate pressure relief device may be used to relieve the pressure, such as a pressure relief valve, or a conventional needle may be inserted into the traditional needle valve to relieve the pressure. For sport balls comprising  
5 self-contained pump mechanisms, it would be beneficial if the pump mechanism also had the capability to relieve the pressure of the ball as desired.

Additionally, it is difficult to obtain a measurement of the pressure within a conventional sport ball. Most pressure indicating devices are configured for determining the pressure of tires or items that employ an outwardly extending  
10 valve stem. Although pressure indicating devices are known for measuring the pressure within a game ball, such devices are generally part of a large separate pump assembly. Additionally, when obtaining a pressure measurement using such known devices, it is common to lose a significant amount of air from the ball while placing the device in communication with the pressurized ball interior.  
15 Accordingly, there is a need for a pressure indicating device which is integral with a sport ball. Furthermore, it would be beneficial if the use of such device did not result in an excessive loss of air from the ball.

### **Summary of the Invention**

20 An object of the present invention is to inflate or add pressure to a sport ball without the need for separate inflation equipment such as a separate inflation needle and pump, and to be able to reduce or relieve the pressure of the ball if necessary.

Another object of the present invention is to easily determine the pressure of a sport ball, without the use of a separate pressure indicating or measuring device.

Another object of the invention is to determine the pressure of a sport ball  
5 without significant loss of air from the pressurized interior of the ball.

The present invention provides a sport ball comprising a self-contained inflation mechanism having an integral pressure relief device. The invention also provides a sport ball comprising multiple self-contained inflation mechanisms in which at least one of the inflation mechanisms includes an integral pressure  
10 relief device. Specifically, the invention relates to a sport ball that has at least one self-contained pump device which is operable from outside the ball and which pumps ambient air into the ball to achieve the desired pressure. The pump also comprises an assembly for reducing or relieving the pressure of the ball. Additionally, the pump may have an integral pressure indicator to  
15 determine the relative pressure of the ball.

Since the pressure in a sport ball can be too high through overinflation or a temperature increase, or too low through underinflation or air loss, it is beneficial to have a pressure relief mechanism, and optionally, a pressure-  
indicating device that is integral with an on-board pump. If the pressure is too  
20 low, additional air may be added using the self-contained pump of the invention. If the pressure is too high, the pressure may be relieved by bleeding pressure from the ball with the pressure relief mechanism described herein. Once the pressure has been relieved, the pressure-indicating device, if present, may then be used to determine if the ball is correctly inflated. If too much air is removed,  
25 additional air may be added using the pump.

In a first aspect, the present invention provides an inflatable sport ball having an integral pump and pressure relief mechanism. The ball comprises a flexible carcass including an inflatable bladder having an interior adapted for retaining pressurized air, and an outer layer disposed on the bladder. The ball  
5 further comprises a pump cylinder secured to the carcass. The cylinder includes a distal end at which is disposed a valve. The cylinder defines an interior hollow chamber in communication with the interior of the bladder through the valve. The ball also comprises a pump piston disposed in the cylinder. The piston is positionable within the cylinder and includes a distal end at which is disposed an  
10 actuating member. The piston and cylinder are configured such that upon selective positioning of the piston, the actuating member engages the valve to selectively provide passage and escape of pressurized air from within the bladder.

In another aspect, the present invention provides an inflatable sport ball  
15 having an integral pump and pressure indicating assembly. The ball comprises a flexible carcass including an inflatable bladder having an interior adapted for retaining pressurized air, and an outer layer disposed on the bladder. The ball further comprises a pump cylinder secured to the carcass. The cylinder includes a nozzle end. The cylinder defines an interior hollow chamber in communication  
20 with the interior of the bladder through the nozzle end. The ball further comprises a pump piston disposed and positionable within the cylinder. The piston includes a distal end, and further includes a pressure indicating assembly. Upon engagement between the distal end of the piston and the nozzle end of the cylinder, the pressure indicating assembly is placed in communication with the

interior of the bladder. This causes the assembly to indicate the pressure within the interior of the ball.

In a further aspect, the present invention provides an inflatable sport ball having an integral pump, pressure relief mechanism, and pressure indicating device. The ball comprises a flexible carcass including an inflatable bladder having an interior adapted for retaining pressurized air, and an outer layer disposed on the bladder. The ball further comprises a pump cylinder secured to the carcass. The cylinder includes a distal end at which is disposed a valve for providing communication with the interior of the bladder. The cylinder defines an interior hollow chamber in communication with the interior of the bladder through the valve. The ball further comprises a pump piston disposed in the cylinder. The piston is positionable within the cylinder. The piston includes a pressure indicating assembly and a distal end at which is disposed an actuating member. The piston and cylinder are configured such that upon selective positioning of the piston, the member engages the valve to selectively provide passage and escape of pressurized air from within the bladder, and the pressure indicating assembly is placed in communication with the interior of the bladder to thereby cause the assembly to indicate the pressure within the ball interior.

In yet a further aspect, the present invention provides a pump adapted for incorporation in an inflatable sport ball. The pump comprises a cylinder having a nozzle end, a valve disposed at the nozzle end, an open end opposite from the nozzle end, and a sidewall extending between the nozzle end and the open end. The open end is adapted for engagement with a carcass of the ball. The pump further comprises a piston movably disposed in the cylinder. The piston includes a distal end at which is disposed an actuating member. The piston and the

cylinder are configured such that upon selective positioning of the piston within the cylinder, the actuating member engages the valve to selectively open the valve.

Other objects of the invention will become apparent from the specification,  
5 drawings and claims.

### **Brief Description of the Drawings**

The following is a brief description of the drawings, which are presented for the purposes of illustrating the invention and not for the purposes of limiting  
10 the same.

Figure 1 is a partial cross-sectional view of a basketball utilizing a preferred embodiment pump in accordance with the present invention.

Figure 2 is a partial cross-sectional view of a football utilizing a preferred embodiment pump in accordance with the present invention.

15 Figure 3 is a detailed cross-sectional view of a portion of the basketball depicted in Figure 1 illustrating a preferred mounting configuration for the preferred pump of the present invention.

Figure 4 is a cross section of a portion of a sport ball with a preferred pump and integral pressure relief device, showing a position in which a pump  
20 piston is pushed down or in a locked position.

Figure 5 illustrates the portion of the sport ball shown in Figure 4 in which the piston is positioned for adding air to the ball.

Figure 6 illustrates the sport ball shown in Figures 4 and 5 in which the piston is pushed farther into the pump cylinder and a one-way valve is opened  
25 by the pressure relief device to allow air to escape from the ball.

Figure 7 is a cross section showing a portion of another preferred embodiment sport ball with a preferred embodiment pump and integral pressure indicating device, showing the piston being pushed down into its locked position.

Figure 8 is another view of the portion of the sport ball shown in Figure 7  
5 in which the piston is positioned for adding air to the ball.

Figure 9 is a cross section of a portion of another preferred embodiment sport ball with another preferred pump having an integral relief device and a pressure indicating device in accordance with the present invention.

Figure 10 illustrates the portion of the sport ball shown in Figure 9 in  
10 which the piston is positioned for adding air to the ball.

Figure 11 illustrates the sport ball shown in Figures 9 and 10 in which the piston is pushed farther into the pump cylinder and a one-way valve is opened by the pressure relief device to allow air to escape from the ball.

Figure 12 is a side view of a piston of the preferred embodiment pump.

15 Figure 13 is a perspective view of a preferred cylinder cap used for securing the pump within a ball.

Figure 14 is a cross section of a preferred nozzle component for use in the pump of the present invention.

Figure 15 is a cross section of a preferred duckbill valve used in the  
20 nozzle component illustrated in Figure 14.

Figure 16 is another preferred embodiment of a game ball according to the present invention.

### **Description of the Preferred Embodiments**

Referring to Figure 1 of the drawings, a sport ball **10** is illustrated incorporating a preferred embodiment inflation pump **5a**, **5b**, or **5c** of the present invention. Details of the various pump embodiments **5a**, **5b**, and **5c** are  
5 described later herein.

The ball **10** is a typical basketball construction comprising a carcass having a rubber bladder **12** for air retention, a layer **14** composed of layers of nylon or polyester yarn windings wrapped around the bladder **12** and an outer rubber layer **16**. As will be understood, the term "carcass" refers to the flexible  
10 body of the ball. For a laminated ball, an additional outer layer **18** of leather or a synthetic material may be used. The layer **18** may comprise panels that are applied by adhesive and set by cold molding to layer **16**. The windings **14** are randomly oriented and two or three layers thick, and they form a layer that cannot be extended to any significant degree. The windings also restrict the ball  
15 **10** from expanding to any significant extent above its regulation size when inflated above its normal playing pressure. This layer **14** for footballs, volleyballs and soccer balls is referred to as a lining layer, and is usually composed of cotton or polyester cloth that is impregnated with a flexible binder resin such as vinyl or latex rubber. The outer layer **18** may be stitched for some sport balls,  
20 such as a soccer ball or a volleyball. The outer layer **18** may optionally have a foam layer backing or a separate foam layer.

Figure 2 illustrates a football **110** incorporating a preferred embodiment inflation pump **5a**, **5b**, or **5c** according to the present invention. The football **110** comprises a carcass having a rubber bladder **112** for air retention, and an outer  
25 layer **118** of leather or synthetic material. As will be appreciated, the carcass of

the football **110** may include one or more additional layers such as a winding layer or reinforcement layer, a foam or backing layer, and a secondary rubber lining layer.

Other sport ball constructions, such as sport balls produced by a molding  
5 process, such as blow molding, may also be used in the invention. For an example of a process for molding sport balls, see, for example, U.S. Patent No. 6,261,400, incorporated herein by reference.

Materials suitable for use as the bladder include, but are not limited to, butyl, latex, urethane, and other rubber materials generally known in the art.  
10 Examples of materials suitable for the winding layer include, but are not limited to, nylon, polyester and the like. Examples of materials suitable for use as the outer layer, or cover, include, but are not limited to, polyurethanes, including thermoplastic polyurethanes; polyvinylchloride (PVC); leather; synthetic leather; and composite leather. Materials suitable for use as the optional foam layer  
15 include, but are not limited to, neoprene, SBR, TPE, EVA, or any foam capable of high or low energy absorption. Examples of commercially available high or low energy absorbing foams include the CONFOR™ open-celled polyurethane foams available from Aearo EAR Specialty composites, Inc., and NEOPRENE™ (polychloroprene) foams available from Dupont Dow Elastomers.

20 Referring to Figure 3, incorporated into the carcass of the preferred embodiment ball **10** of the present invention during its formation is a rubber pump boot or housing **20**. The boot **20** defines a central opening and has an outwardly extending flange **22** which is preferably bonded to the bladder **12** using a rubber adhesive. The boot **20** is preferably disposed between the rubber  
25 bladder **12** and the layer of windings **14**. The boot **20** may be constructed of any

suitable material, such as butyl rubber, natural rubber, urethane rubber, or any suitable elastomer or rubber material known in the art, or combinations thereof. A molding plug (not shown) is inserted into the boot opening during the molding and winding process to maintain the proper shape of the central opening and to  
5 allow the bladder **12** to be inflated during the manufacturing process. The molding plug is preferably aluminum, composite or rubber, and most preferably aluminum.

The central opening through the boot **20** is preferably configured with a groove **24** to hold a flange extending from the upper end of a pump cylinder,  
10 described in greater detail herein. The pump cylinder can optionally be bonded to the boot **20** using any suitable flexible adhesive (such as epoxy, urethane, cyanoacrylate, or any other flexible adhesive known in the art).

Referring to Figures 4-6, a preferred embodiment pump **5a** having an integral pressure relief device is shown. The pump **5a** comprises a pump piston  
15 **30** disposed in a pump cylinder **28**. The pump cylinder **28** includes an open end **26**, an exit nozzle **46** defined at an opposite distal end from the open end **26**, and a cylindrical sidewall **27** extending between the open end **26** and the exit nozzle **46**. The sidewall **27** has an interior face **29**. The cylinder **28** also defines an interior end wall **25** which faces the open end **26**. The cylinder **28** defines a  
20 hollow chamber formed from the interior face **29** of the sidewall **27** and the end wall **25**. Although the pump cylinder shown is a right cylinder, other cylinders that are not right cylinders, such as a cylinder having a non-circular cross-section, may be used.

Sealingly disposed within the hollow chamber of the cylinder **28** is the  
25 piston **30**. The piston **30** includes a cap end **58**, and a sealing end **35** opposite

from the cap end **58**. Extending between the cap end **58** and the sealing end **35** is a body component **33**. Defined along the sealing end **35** of the piston **30** is a recess **36** extending along the outer periphery of the body **33**, for retaining an O-ring **38**. As seen in the referenced figures, this recess **36** is dimensioned such  
5 that the O-ring **38** can move in the recess **36**. The O-ring **38** is forced into the position shown in Figure 4 for instance, when the piston **30** is pushed down. In this position, the O-ring seals between the interior face **29** of the cylinder sidewall and an upper flange **40** of the recess **36**.

The piston **30** further defines an annular recess **32** accessible from the  
10 sealing end **35** of the piston **30** that preferably houses a spring **34**. The spring is preferably a coil spring and positioned to urge the piston **30** in the cylinder **28** in a direction away from the cylinder exit nozzle **46**. This configuration is preferred for pumps having an integral pressure relief mechanism as described herein. In these embodiments, the function of the spring is to maintain separation between  
15 the sealing end **35** of the piston **30** and a valve used for releasing air from the ball. This aspect is described in greater detail herein. It will be appreciated that the present invention pumps include piston configurations that do not include the noted annular recess **32** or spring **34**.

As noted, a feature of the pump of the present invention is the provision of  
20 an integral pressure relief mechanism. The preferred pump **5a** under discussion provides such a mechanism as follows. The piston **30** includes a needle or other suitable device **90** such that upon suitable positioning of the piston **30**, the needle **90** forces a valve **68** open to allow air to escape (see Figure 6). The valve **68** is preferably positioned at the end of the cylinder **28** near the exit  
25 nozzle **46**. The valve **68** is preferably a one-way valve. The needle **90** is

mounted to the sealing end **35** of the piston **30** in any suitable manner. In the embodiment shown, the piston **30** has an opening or passage extending through it to receive the needle **90**. The opening or passage also provides an exit for air released from the pressurized interior of the ball. The needle **90** is mounted in or  
5 on the piston **30** preferably by adhesive bonding. The needle **90** can be constructed of any suitable material, such as, but not limited to, polycarbonate (PC), polystyrene (PS), acrylic (PMMA), acrylonitrile-styrene acrylate (ASA), polyethylene terephthalate (PET), acrylonitrile-butadiene styrene (ABS) copolymer, ABS/PC blends, polypropylene (preferably high impact  
10 polypropylene), polyphenylene oxide, nylon, combinations thereof, or any suitable material known in the art. Materials with high impact strength are preferred. Alternatively, the piston **30** and needle **90** may be formed as one piece or in one operation of the same or different materials. The needle **90** may also in some embodiments, be provided with an interior passage to further  
15 facilitate the passage of air from the interior of the ball.

The piston **30** undergoes several functions depending upon its relative position within the cylinder **28**. In Figure 4, the piston **30** is in a locked or secure position such as when the ball **10** is in use. In this position, it is preferred that the outer surface of the cap end **58** of the piston **30** is flush with the outer  
20 surface of the ball **10**. In Figure 5, the piston **30** is in an unlocked position in which the pump **5a** may be used to add air to the ball **10**. In Figure 6, the piston **30** is displaced downward into the cylinder **28** such that the distal end of the needle **90** extends into or through the valve **68** to selectively allow escape of air from the ball **10**. As will be understood, the piston **30** is placed in the position  
25 shown in Figure 6 to activate the pressure relief mechanism of the pump.

In another embodiment of the invention (not shown), the piston **30** of the pump **5a** includes a button or valve that activates a device, such as a needle, to open the valve **68**. The button could be accessible from the exterior of the ball. In one position when the button is pushed, the needle is engaged with the valve **68** to allow air to escape from the ball interior. When the button or valve is released, the needle is retracted and the valve **68** closes and seals. That is, the button or valve may have two positions, in which the first position opens the valve **68** and allows air to escape, and the second position retracts the needle or device and allows the valve **68** to close or seal. A spring or other member can be used to urge the button or valve to a default position.

Figures 7 and 8 illustrate another embodiment sport ball **10** of the present invention. Figures 7 and 8 depict a ball **10** having a preferred embodiment pump **5b** including a pressure indicating device **72**. The device **72** may be in the form of a movable sphere retained within a hollow region defined in the piston **30**, or may be in the form of a plurality of pressure indication lines disposed along the length of the piston **30**. In determining the pressure of the ball **10**, air is allowed to escape the ball and indicate the pressure by displacing the device **72** to a relative position. This position may be further indicated by pressure indication lines **70**. A variety of configurations for the cylinder **28** and the piston **30** may be used to selectively allow passage and escape of pressurized air from the ball **10**. For example, the distal end of the piston **30** may, upon further displacement into the cylinder, engage a valve such as located in the nozzle of the cylinder or elsewhere, to allow passage of air from the ball, through the hollow region of the piston. An example of a preferred valve and its incorporation in a pump assembly is valve **68** shown in Fig. 4. Flow of air through or past the piston is

utilized to activate a pressure indicating device. A preferred pressure indicating device is the previously described sphere **72** that is displaced upward within the hollow region of the piston during escape of pressurized air from the ball. The flow rate of such air is proportional to the pressure of the air within the ball.

5 Depending upon the rate of air flow past the sphere **72**, the sphere will be displaced a certain distance within the hollow region of the piston. As noted, it is preferred that the position of the sphere **72** within the piston may be observed. The relative position may be readily noted by providing one or more pressure indication lines **70** to which the position of the sphere **72** may be compared.

10 It is also contemplated to use the piston **30** and its relative position within the cylinder **28** to indicate the pressure of the ball. In this embodiment, the piston **30** is backed by a spring which counters the force exerted upon the displaced piston **30** by the pressurized air from the ball interior. The position of the piston **30** indicates the ball pressure.

15 Details of the components of an alternative embodiment, i.e., the pump **5b**, such as piston **30** and cylinder **28**, are as previously described in conjunction with Figures 4-6. Related to this embodiment, is a pressure indicating device which features a design in which an indicator is actuated without loss of air from the ball. The previously described embodiment utilized a design in which the  
20 pressure of the ball was indicated by a characteristic of a flowing air stream allowed to exit the ball. The alternate design under discussion provides a measure of the ball interior pressure by exposing a pressure indicating surface to the interior pressure. For example, a flexible diaphragm or other member could be exposed to the ball interior. Upon such exposure, the pressurized air of the  
25 interior would displace the diaphragm by a certain amount which could then be

correlated to a pressure value. A preferred assembly using this design is the previously described piston which is backed or otherwise countered by a spring. A face of the piston such as the sealing end **35**, is exposed to the ball interior, which results in a force being exerted on the piston causing displacement of the  
5 piston within the cylinder. The relative movement of the piston is then correlated to the interior pressure of the ball.

In another embodiment of the invention, shown in Figures 9-11, a preferred embodiment pump **5c** includes a pressure indicating device **72** in conjunction with a pressure relieving mechanism. The piston **30** includes a  
10 pressure indicating device **72**, such as a movable sphere or graduated slide. The piston **30** may also provide pressure indication lines **70**. In determining the pressure of the ball **10**, air is allowed to escape the ball and indicate the pressure by displacing the device **72** to a relative position thereby indicating the pressure of the ball interior. This position may be further indicated by pressure  
15 indication lines provided along the length of the piston **30**. One way of achieving this is to allow the one way valve **68** to be opened by the piston **30** of the pump **5c**. This allows air to escape from the interior of the ball **10** and actuate or move the pressure indication device **72** in the piston **30** due to air flowing through it and exiting the ball **10**. In a preferred version, a calibrated spring is provided  
20 backing the pressure indication device **72** that allows for precise movement of the pressure indicating device **72** when the air from the interior of the game ball **10** pushes against and flows by the pressure indicating piece **72**. Details of the other components of the pump **5c**, such as piston **30** and cylinder **28**, are as previously described in conjunction with Figures 4-6.

The preferred embodiment sport balls utilize a particular mounting configuration for securing and incorporating the pumps, such as the preferred embodiment pumps **5a**, **5b**, and **5c**, within the interior of the ball.

As shown in Figure 12, the exterior of the pump piston **30** preferably  
5 defines a plurality of recesses or slots **42** in the recess **36** extending from just below the upper flange **40** through a lower or distal most flange **44**. Only one of these slots **42** is shown in Figure 12 but there are preferably two or more. When the piston **30** is forced up by the spring **34**, the O-ring **38** moves to the bottom of the recess **36** which opens up a by-pass region around the O-ring **38** through the  
10 slots **42** so that air can enter the cylinder **28** below the piston **30**. Then, when the piston **30** is pushed down, the O-ring **38** moves back up to the top of the groove and seals to force the air out through the cylinder exit nozzle **46**.

At the upper end of the piston **30**, two outwardly extending flanges **48** are provided that cooperate with a cylinder cap **50** shown in Figure 13 to hold the  
15 piston **30** down in the cylinder **28** and to release the piston **30** for pumping. The cylinder cap **50** is fixed onto the top of the cylinder **28** and the piston **30** extends through the center of the cylinder cap **50**. The cap **50** is preferably cemented into the cylinder **28** using a suitable adhesive, such as a UV cured adhesive. Figure 13 shows an isometric view of the underside of the cylinder cap **50** and  
20 illustrates open areas **52** on opposite sides of the central opening through which the two flanges **48** on the piston **30** can pass in the unlocked position. In the locked position, the piston **30** is pushed down and rotated such that the two flanges **48** pass under projections **54** and are rotated into locking recesses **56**.

Referring to Figures 4-11, attached to the upper end of the piston **30** is a  
25 button or cap **58** that is designed to essentially completely fill the hole in the ball

carcass. In some embodiments, such as a basketball or football, the button or cap **58** is preferably flush or essentially flush with the surface of the ball. In other embodiments, such as a soccer ball, the button or cap **58** is preferably disposed below the surface of the ball. This button **58** may be of any desired material.

5 Examples of materials suitable for use as the button or cap **58** include urethane rubber, butyl rubber, natural rubber or any other material known in the art. A preferred rubber for use as the button or cap is a thermoplastic vulcanizate such as SANTOPRENE™ rubber, available from Advanced Elastomer Systems, Akron, Ohio. The upper surface of the button or cap **58** should preferably be  
10 flexible to match the texture and feel of the outer surface of the ball. For example, the button in a basketball may be textured to match the feel of the cover, while for other sport balls, such as a soccer ball or football, the top of the button or cap may be smooth.

In a preferred embodiment, fibers or other reinforcing materials may be  
15 incorporated into the rubber compound or thermoplastic material of the button **58** during mixing. Examples of fibers or materials suitable for use include, but are not limited to, polyester, polyamide, polypropylene, Kevlar, cellulosic, glass and combinations thereof. Incorporation of fibers or other reinforcing materials into the button or cap **58** improves the durability of the button and improves the union  
20 of the button or cap and the piston **30**, thus preventing the button or cap from shearing off during use. Although the pump would still function without the button, it would become very difficult to use.

Preferably, the button or cap **58** is co-injected with the piston **30** as one part. Alternatively, the button or cap **58** may be co-injected with a connecting  
25 piece, and the button or cap **58** and connecting piece may then be attached to

the upper end of the piston **30** using an adhesive suitable for bonding the two pieces together. Co-injecting the button **58** and the piston **30** as one part, or alternatively, the button **58** and the connecting piece as one part that is mounted to the piston, provides a more durable part that is less likely to break or come  
5 apart during routine use of the ball. The button or cap material and the piston material need to be selected such that the two materials will adhere when co-injected. Testing of various combinations has shown that co-injecting or extruding a soft rubber button, such as a button comprising SANTOPRENE™, and a harder piston, such as polycarbonate or polypropylene and the like,  
10 provides a durable bond without the need for adhesives.

The piston and the connecting piece may be formed of any suitable material, such as, but not limited to polycarbonate (PC), polystyrene (PS), acrylic (PMMA), acrylonitrile-styrene acrylate (ASA), polyethylene terephthalate (PET), acrylonitrile-butadiene styrene (ABS) copolymer, ABS/PS blends, polypropylene  
15 (preferably high impact polypropylene), polyphenylene oxide, nylon, combinations thereof, or any suitable material known in the art. Materials with high impact strength are preferred. The material used for the piston is preferably clear or transparent to allow the pressure-indicating device **72** to be viewed by the user.

20 As further illustrated in Figures 4-11, preferably mounted on the upper surface of the cylinder cap **50** is a pad **60** that is engaged by the button **58** when the piston **30** is pushed down against the previously described spring **34** to lock or unlock the piston **30**. The pad **60** provides cushioning to the pump. The underside of the cap **58** may be flexible or soft to provide further cushioning to  
25 the pump.

Figures 4-11 of the drawings depict a pump exit nozzle **46**. Shown in Figure 14 is a preferred embodiment of a one-way valve assembly **70** of the duckbill-type to be mounted in the nozzle **46**. This assembly **70** comprises an inlet end piece **74**, an outlet end piece **72** and an elastomeric duckbill valve **80**  
5 captured between the two end pieces **72**, **74**. The end pieces **72** and **74** are preferably plastic, such as a polycarbonate, polypropylene, nylon, polyethylene, or combinations thereof, but may be any material suitable for use. The end pieces may be ultrasonically welded together. Although any desired one-way valve can be used on the exit nozzle **70** and although duckbill valves are a  
10 common type of one-way valves, a specific duckbill configuration is shown in Figure 15. The duckbill valve **80** is preferably formed of an elastomeric silicone material and is molded with a cylindrical barrel **82** having a flange **84**. Inside of the barrel **82** is the duckbill **86** which has an upper inlet end **88** molded around the inside circumference into the barrel **82**. The walls or sides **90** of the duckbill  
15 **86** then taper down to form the straight-line lower end with the duckbill slit **92**. The duckbill functions wherein inlet air pressure forces the duckbill slit **92** open to admit air while the air pressure inside of the ball squeezes the duckbill slit closed to prevent the leakage of air. Such a duckbill structure is commercially available from Vernay Laboratories, Inc. of Yellow Springs, Ohio. Any type of  
20 one-way valve or other valve capable of sealing known in the art may be used, as long as it prevents air from flowing out of the interior of the ball when not desired.

A pump assembly of the type described and illustrated in the referenced figures is preferably made primarily from plastics such as polystyrene,  
25 polyethylene, nylon, polycarbonate and combinations thereof, but it can be made

of any appropriate material known in the art. Although the assembly is small and light weight, perhaps only about 5 to about 25 grams, a weight may optionally be added to the ball structure to counterbalance the weight of the pump mechanism. In such an application, the weight, i.e. the counterweight, is positioned on or within the ball, and has a suitable mass, such that the resulting center of mass of the ball coincides with the geometric center of the ball. In lighter weight or smaller balls, such as a soccer ball, the pump assembly may weigh less and/or be smaller (shorter) than a corresponding pump assembly for a heavier ball, such as a basketball. Figure 16 illustrates such a counterbalance arrangement wherein a pump mechanism generally designated **5a, 5b, 5c** is on one side of the ball and a standard needle valve **100** is on the opposite side of the ball. In this case, the material **102** forming the needle valve **100** is weighted. Additional material can be added to the needle valve housing or the region surrounding the valve. Alternatively, a dense metal powder such as tungsten could be added to the rubber compound. The use of another pump or inflation valve is referred to herein as a secondary pump or inflation valve.

The description and the drawings referenced herein describe a particular and one preferred pump arrangement. However, other pump arrangements can be used within the scope of the invention. Examples of other pump arrangements that may be used with the invention are shown in co-pending Application Serial Nos. 09/594,980, filed June 15, 2000; 09/594,547, filed June 14, 2000; 09/594,180, filed June 14, 2000; and 09/560,768, filed April 28, 2000, incorporated herein by reference. Additional details and features that may be implemented in conjunction with the balls and pumps described herein are provided in U.S. Application publication No. US 2002/187866, filed as Serial No.

10/183,337 on June 25, 2002; U.S. Patent No. 6,491,595, filed as Serial No. 09/712,116 on November 14, 2000; and U.S. Patent No. 6,287,225 filed as Serial No. 09/478,225 on January 6, 2000, all of which are hereby incorporated by reference.

5           The foregoing description is, at present, considered to be the preferred embodiments of the present invention. However, it is contemplated that various changes and modifications apparent to those skilled in the art may be made without departing from the present invention. Therefore, the foregoing description is intended to cover all such changes and modifications  
10 encompassed within the spirit and scope of the present invention, including all equivalent aspects.